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Use of Corn Dried Distillers Grains to Improve Feed Diets for Intensive Lamb Fattening

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ABSTRACT

Background: The increasing price of raw materials used in lambs fattening diets imposes to look for cheaper feedstuff able to replace the traditional and more expensive ingredients. This study aimed to investigate the effect of including corn dried distillers grains as a feed ingredient in lambs fattening diet.

Methods: The study was performed during the year 2021. Thirty lambs (aged 3 months) were divided randomly into two groups (15 lambs/group). The experiment lasted for 110 days divided in two fattening phases. The groups were fed with diets of compound feed, barley hay and corn silage differentiated by the inclusion level of corn dried distiller's grain in compound feed. Diets were isoprotein and isoenergetic.

Result: The results of this study showed that the inclusion of corn dried distillers grain in lamb's diets improved feed consumption, feed cost, growth performance and carcass parameters. These results proved that it is an efficient and economical feed ingredient that can be used successfully by farmers in lambs fattening diets as a single source of protein and energy in the compound feed up to 30 kg live weight and as a substitute for sunflower meal, over this body weight.

Key words: Corn dried distillers grain, Diets, Fattening, Feed, Lambs.

INTRODUCTION

The rising price of raw materials used to produce animal feed is compelling nutritionists to look for new and cheaper feedstuff that can replace the more expensive traditional energy and protein ingredients such as corn and groats. In recent times, the by-products in animal feed for fattening have come back to use, including corn dried distillers grain, a by-product resulting from the ethyl alcohol preparation from corn kernels (Abdelrahim *et al.*, 2014; Pecka-Kiełb *et al.,* 2017; Crane *et al.,* 2018; Neville *et al.*, 2021).

This by-product is considered to have a high content of protein, energy and phosphorus due to the remaining nutrients (protein, fat, fiber) which are concentrated about 3-fold when the starch in corn is fermented to produce ethyl alcohol (Klopfenstein *et al.*, 2008; Kim *et al.,* 2015).

Protein and amino acid utilization of corn dried distillers grains has been evaluated in growing lambs and the results indicated that this by-product represents an excellent source of protein (Archibeque *et al.*, 2008). Moreover, the high supply and corn price has made dried corn distillers grains a very attractive source of energy for ruminants (Klopfenstein *et al.*, 2008; Hodges *et al.*, 2020).

When used as feed for raising or finishing lambs, corn dried distillers grain can be used at a level of inclusion of up to 60% of the dry matter in the diet, being both a source of energy and a source of protein (Neville *et al.*, 2021). The inclusion of corn dried distillers grains in lamb diets has tended to be more economical for producers, being generally a practical, cost-effective source of protein, which is usually beneficial as protein represents the most expensive fraction of the diet (Sahin *et al.,* 2013).

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In general, corn dried distillers grains can be used as a source of protein or energy in lambs' rearing and finishing diets, according to the nutritional needs, type of food used and cost concerns (Curzaynz-Leyva *et al.*, 2019).

The aim of this study was to investigate the effect of including corn dried distillers grains as a single source of protein and energy in the compound feed of the fattening lambs diet up to 30 kg live weight and as a substitute for sunflower meal over this body weight.

MATERIALS AND METHODS

Location, animals and feeding

The animals in this experiment have been cared for in accordance with the Romanian Law 43/2014 on protection

of experimental animals, as well as with EU Council Directive 98/58/EC on protection of farm animals. The experiment took place in the National Research-Development Institute for Animal Nutrition and Biology, Balotesti, Romania (IBNA-Balotesti), in 2021, in accordance with the provisions on the animal study protocol approved by the Ethics Committee of IBNA-Balotesti (approval No. 146 / 12.07.2020). During the experiment, all animals remained healthy and no veterinary drugs were used.

The research work was carried out on 30 lambs, which were randomly divided into two batches (15 lambs/group) for a total fattening period of 110 days, until reaching a body weight of about 40 kg. The fattening period was divided into two phases (the former phase - of 50 days, the latter - 60 days) and the rations of the lambs were formulated in according to the feed requirements of the French system (INRA, 2010).

The batches were fed with meals consisting of compound feed, barley hay and corn silage. The structure of the compound feed (CF) given during the two fattening phases (Table 1) made the difference between the batches. Thus, group T_1 (control group) received compound feed consisting in corn, sunflower meal, mineral salts and premix in both fattening phases, while group T_2 (experimental group) received compound feed formed in the first fattening phase of corn dried distillers grains (95%) and mineral salts plus premix (5%) and in the second phase compound feed consisting of corn (46%), corn dried distillers grains (49%), mineral salts and premix (5%).

Corn dried distillers grains (DDG) completely replaced corn and sunflower meal in the first fattening phase (43% of the total dry matter of the ration) and in the second fattening phase completely replaced sunflower meal (20% of the total dry matter of the ration). All diets were isoprotein and isoenergetic.

The structure of the CF recipes was established taking into account the energy and nutrient requirements of lambs in the two fattening stages. The compound feeds as well as the bulk feeds (barley hay and corn silage) were administered *ad libitum*, according to the daily feed diets as established for each batch according to the fattening phases.

The calculation for the nutritional value (Table 1 and Table 2) of feeds and fodder was based on the French system (INRA, 2010). The biological material investigated consisted of lambs belonging to the *Palas Merino* breed. Only female lambs from single births were chosen for the

Table 1: Structure and nutritional value of compound feed recipes used in lambs' diets.

Specification	Treatments			
	T1		T2	
	First fattening phase	Second fattening phase	First fattening phase	Second fattening phase
Maize (%)	48	69	-	46
Sunflower meal (%)	48	26	-	-
DDG (%)	-	-	95	49
Calcium carbonate (%)	2	2.5	2	2
Dicalcium phosphate (%)	-	-	1	0.5
Salt (%)	1	2.5	1	1.5
Vitamin-mineral premix (%)	1	1	1	1
Total (%)	100	100	100	100
Nutritional value				
DM (%)	89.12	89.84	89.28	88.77
UFV (units/kg fodder)	1.03	1.14	1.02	1.16
CP (g/kg fodder)	200.40	147.01	199.83	144.05
PDIN (g/kg fodder)	143.48	109.13	139.65	105.61
PDIE (g/kg fodder)	108.48	96.06	105.45	95.58
Ca (g/kg fodder)	9.61	10.68	10.14	10.33
P (g/kg fodder)	5.90	4.19	5.27	4.24

DM: Dry matter; CF: Compound feed; CP: Crude protein; UFV: Net energy value for meat maintenancence and production; PDIN: Protein digestible in the intestine allowed by the nitrogen content of the ration; PDIE- Protein digestible at the intestinal level allowed by the energy content of the ration; DDG: Corn dried distillers grains.

Table 2: Nutritional value of corn dried distillers grains (DDG) and fodders used in lambs' diets.

Specification	DM (%)	UFV (UFV/kg fodder)	PDIN (g/kg fodder)	PDIE (g/kg fodder)	CP (g/kg fodder)	EE (g/kg fodder)	CC (g/kg fodder)	Ca (g/kg fodder)	P (g/kg fodder)
Barley hay	85.00	0.64	50	61	85	27	290	7.0	1.2
Corn silo	26.00	0.20	13	17	22	8	85	1.2	0.5
DDG	89.00	1.07	147	111	210	10	126	0.14	0.91

experiment, lambs that were weaned at the age of 3 months and had an average body weight at the beginning of the experiment of 19.87±0.36 kg for group T_1 and 19.93±0.29 kg for group T_2. All lambs were housed in collective pens (15 lambs/pen) during the experimental period and the pen was equipped with a suitable drinker and feeder for all 15 lambs (each pen had an area of 24 m^2).

Feed consumption, growth performance and meat parameters

Chemical analysis of lamb fodder was carried out using official methods of feed analysis (EC Regulation No 152/2009). The corn dried distillers grains used in this study was purchased from a single source and a single production batch, while the other fodder was prepared in IBNA-Balotesti. Feeds were administered twice a day (at 08.00 AM and 04.30 PM) and the control of their consumption was done by weighing them at the moment of distribution and the refusals at every morning before feeding. The animals had *ad libitum* access to water throughout the study. Consumption of UFV (net energy value for meat maintenance and production), DM (dry matter), PDIN (protein digestible in the intestine allowed by the nitrogen content of the ration) and PDIE (protein digestible at the intestinal level allowed by the energy content of the ration)/per kg gain were calculated for the entire fattening period.

In order to highlight the dynamics of lamb growth and fattening, the individual weighing of the lambs was performed in different stages of fattening. Based on these data, the evolution of body weight (BW) and average daily gain (ADG) was established throughout the entire fattening period.

At the end of the fattening period, five lambs from each group were slaughtered and slaughter weight, carcass weight, slaughter yield, muscle surface area and carcass tissue structure were established. The slaughter of the animals was done after 12 hours of fasting and the weight of the carcass was determined after a cooling period of 24 hours at a temperature from 0 to + 4°C (cold carcass). Based on the ratio between carcass weight and live weight were calculated the slaughter yield. The surface of muscle (section of *Longissimus dorsi* muscle at the level between the 12^{th} and 13^{th} ribs) was determined using the planimetric method.

Statistical analysis

The results were presented as mean values±standard errors of mean. Microsoft Office Excel 2016 was used to calculate all statistical parameters (mean, standard deviation, coefficient of variability and standard error of average values) and t-test (Student) to determine the significance of the difference between the mean values. The differences were considered statistically significant at $P<0.05$ and indicated by superscripts.

RESULTS AND DISCUSSION

Feed consumption

Pursuant the results obtained (Table 3) it was found that over the entire fattening period the average amount of daily dry matter intake (DMI) expressed in kg/head/day was 2.3% lower in group T_2 compared to group T_1, the differences being insignificant ($P>0.05$).

Regarding feeding efficiency, the lambs from the T_2 group had at all analyzed parameters (consumption of compound feed, DM, UFV, PDIN and PDIE/kg of gain) superior values of conversion into gain (between 5.5 and 8.3%) compared with lambs from T_1 group. In addition, the feed conversion ratio (FCR), was better in group T_2 compared to group T_1 and the feed cost was 19.4% lower for the T_2 group of lambs fed with DDG.

These results allowed us to conclude that DDG is an efficient and economical feed ingredient that can be used successfully by farmers in lambs fattening diets as a single source of protein and energy in the compound feed up to 30 kg live weight and as a substitute for sunflower meal, over this body weight.

The results of our study agree with previous literature (Gabr *et al*., 2010; Felix *et al*., 2012; Van Emon *et al*., 2012; Abdelrahim *et al.,* 2014) which showed that DDGS inclusion in fattening diets of lambs had not increased DMI or feed conversion rates. Contrary to our findings, other studies found a significant increase in DMI consumption when growing lambs received diets with different levels of DDGS (Schauer *et al*., 2008; Curzaynz-Leyva *et al.,* 2019).

In a complex analysis of the impact of the inclusion of DDGS in fattening lamb diets Neville *et al.* (2021) showed that the consumption of DMI improves when DDGS is included at rates less than 30% of the ration dry matter, while the inclusion of DDGS at greater than or equal to 30% seems to decrease DMI. Decreased DMI can be attributed to increased dietary crude protein in DDGS - fed lambs (Van Emon *et al*., 2012).

Growth performance

As regards the evolution of the body weight of the lambs during fattening (Table 4), it was found that at the end of the fattening period (110 days) there were no statistical

Table 3: The effects of feeding corn dried distillers grains (DDG) on feed consumption of lambs.

Specification	Total fattening period	
	T_1	T_2
DMI (kg/head/day)	1.173	1.146
ADI (kg/head/day)	2.432	2.394
Compound feed (kg/kg gain)	3.13	2.90
DM (kg/kg gain)	6.50	6.16
UFV (units/kg gain)	6.24	5.85
PDIN (g/kg gain)	588.5	543.6
PDIE (g/kg gain)	569.7	534.6
FCR (feed intake/live weight gain)	13.48	12.88
Feed cost ($/kg gain)	2.084	1.745

ADI: Average daily intake; DM: Dry matter intake FCR: Feed conversion ratio; Feed cost- 2021 average annual exchange rate for 1 US Dollar: 4.1604 RON.

differences (P>0.05) between groups T_1 and T_2 regarding the average body weight of lambs (39.71±0.45 kg vs. 40.38 ±0.32). No statistical differences (P>0.05) were found either for the average daily gain (180.9±4.4 g for T_1 and 186.3± 3.7 g for T_2).

The higher weight gain of lambs in group T_2 compared to those in group T_1 could be explained by the fact that corn dried distillers grain contains 15 to 20% undegradable intake protein (UIP) and 8 to 12% fat which makes possible this additional increase in weight gain (Abdelrahim *et al.*, 2014). In general, the average daily gain increases most when DDGS is included at rates between 20-30% of the dry matter of the ration and less when it is included at rates above 40% (Neville *et al*., 2021).

Similarly to the results recorded in this study, previous research (Schauer *et al.,* 2008; Gabr *et al.,* 2010; Van Emon *et al*., 2012; Sahin *et al*., 2013) showed that including DDGS in fattening diets of lambs have not negatively influenced ADG and BW.

In contrast to the present study, Klopfenstein *et al.* (2008) noticed a quadratic response in ADG as the level of DDGS in the beef cattle diet increased from 0 to 40%. Also, Curzaynz-Leyva *et al.* (2019) found significantly higher values (P<0.05) for ADG and BW in the groups of lambs fed with levels of 15, 30 and 45% DDGS (% of the DM ration) compared to the control group (0% DDGS).

According to the results obtained in the present study, BW and ADG had higher values in group T_2 than group T_1, which led to the conclusion that the inclusion of corn dried distillers grain in feed diets had a beneficial effect on lamb growth performance.

Meat parameters

As regards the carcass parameters observed in the present study (live slaughter weight, carcass weight, slaughter yield and *Longissimus dorsi* muscle area), it was found that they had higher values in group T_2 compared to group T_1 (Table 5), yet such differences are not statistically different (P>0.05).

In general, the results reported in the specialty literature showed that the inclusion of DDG in the lambs fattening diets led to no significant differences and no negative effects on carcass parameters, which are in accord with the results obtained in our study (Schauer *et al.,* 2008; Van Emon *et al*., 2012; Abdelrahim *et al.,* 2014; Hodges *et al.,* 2020).

Contrary to the results obtained in the present study, Curzaynz-Leyva *et al.* (2019) found that the inclusion of DDGS at 30 and 45% from DM levels of ration in lamb feed significantly improves (P<0.05) slaughter yield and carcass weight.

Table 4: The effects of feeding corn dried distillers grains (DDG) on growth performance of lambs.

Specification	T_1	T_2	p-value
Initial weight[1] (kg)	19.87±0.36	19.93±0.29	0.454
Intermediate weight[2] (kg)	29.21±0.38	29.45±0.35	0.317
Final weight[3] (kg)	39.71±0.45	40.38±0.32	0.119
ADG $_{1-2}$ (g)	186.7±7.9	190.5±5.7	0.347
ADG $_{2-3}$ (g)	175.1±7.7	182.1±5.1	0.228
ADG $_{1-3}$ (g)	180.9±4.4	186.3±3.7	0.178

[a,b] Within a row, means without a common superscript differ (P<0.05).

Table 5: The effects of feeding corn dried distillers grains (DDG) on carcass parameters of lambs.

Specification	T_1	T_2	p-value
Weight at slaughter (kg)	39.68±0.55	40.36±0.51	0.196
Carcass weight (kg)	18.61±0.38	19.04±0.40	0.221
Slaughter yield (%)	47.26±0.39	47.58±0.29	0.262
Muscle surface (cm^2)	14.34±0.27	14.52±0.30	0.334

[a,b] Within a row, means without a common superscript differ (P<0.05).

CONCLUSION

Based on the results of this study, it can be concluded that the inclusion of DDG in the lamb diet improved the consumption of dry matter intake, feed conversion rate, body weight, average daily gain and carcass parameters such that it can be recommended to be used in the lambs fattening diets as a single source of protein and energy in the compound feed up to 30 kg live weight and as a substitute for sunflower meal over this body weight. In addition, the feed cost is 19.4% lower for the batch of lambs fed with this by-product. Thus, the decision to include DDG as a feed ingredient in lambs fattening diets depends on the price and availability of cereals and groats on the market.

Conflict of interest: None.

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